

What is claimed is:

1. A magnetic recording disk comprising:
 - a substrate;
 - a first lower ferromagnetic layer on the substrate and having a remanent magnetization M_r , a thickness t and a remanent-magnetization-thickness product Mrt :
 - a first antiferromagnetically coupling layer on the first lower ferromagnetic layer;
 - a second lower ferromagnetic layer on the first antiferromagnetically coupling layer and having an Mrt less than the Mrt of the first lower ferromagnetic layer;
 - a third lower ferromagnetic layer on the second antiferromagnetically coupling layer and having an Mrt greater than the Mrt of the second lower ferromagnetic layer;
 - a third antiferromagnetically coupling layer on the third lower ferromagnetic layer; and
 - an upper ferromagnetic layer on the third antiferromagnetically coupling layer and having an Mrt greater than the sum of the Mrt values of the first and third lower ferromagnetic layers.
2. The disk of claim 1 wherein the lower ferromagnetic layers are formed of substantially the same material, and wherein the second ferromagnetic layer has a thickness less than the thickness of each of the first and third lower ferromagnetic layers.

3. The disk of claim 1 further comprising;
a fourth lower ferromagnetic layer on the third antiferromagnetically coupling layer;
a fourth antiferromagnetically coupling layer on the fourth lower ferromagnetic layer;
a fifth lower ferromagnetic layer on the fourth antiferromagnetically coupling layer;
and
a fifth antiferromagnetically coupling layer on the fifth lower ferromagnetic layer; and
wherein the upper ferromagnetic layer is formed directly on the fifth antiferromagnetically coupling layer and has an Mrt greater than the sum of the Mrt values of the first, third and fifth lower ferromagnetic layers.

4. The disk of claim 1 wherein the upper ferromagnetic layer is an alloy comprising Co, Pt, Cr and B, and wherein each of the lower ferromagnetic layers is an alloy comprising Co and Cr.

5. The disk of claim 4 wherein each of the lower ferromagnetic layers is an alloy further comprising Ta.

6. The disk of claim 1 wherein each of the antiferromagnetically coupling layers a material selected from the group consisting of ruthenium (Ru), chromium (Cr), rhodium (Rh), iridium (Ir), copper (Cu), and their alloys.

7. The disk of claim 1 further comprising an underlayer located on the substrate between the substrate and the first lower ferromagnetic layer.

8. The disk of claim 1 further comprising a protective overcoat formed over the upper ferromagnetic layer.

9. A magnetic recording disk comprising:

a substrate; and

an antiferromagnetically-coupled structure on the substrate and having two remanent magnetic states in the absence of an applied magnetic field, the structure comprising

(a) a first lower ferromagnetic layer having a remanent magnetization M_r , a thickness t and a remanent-magnetization-thickness product Mrt ; (b) a first antiferromagnetically coupling layer on the first lower ferromagnetic layer; (c) a second lower ferromagnetic layer on the first antiferromagnetically coupling layer and having an Mrt less than the Mrt of the first lower ferromagnetic layer; (d) a third lower ferromagnetic layer on the second antiferromagnetically coupling layer and having an Mrt greater than the Mrt of the second lower ferromagnetic layer; (e) a third antiferromagnetically coupling layer on the third lower ferromagnetic layer; and (f) an upper ferromagnetic layer on the third antiferromagnetically coupling layer and having an Mrt greater than the sum of the Mrt values of the first and third lower ferromagnetic layers;

and wherein the magnetization directions of the upper ferromagnetic layer and the third ferromagnetic layer are substantially antiparallel in each remanent state, the magnetization directions of the second lower ferromagnetic layer and the first ferromagnetic layer are substantially antiparallel in each remanent state, and the magnetization direction of the upper ferromagnetic layer in one remanent state is substantially antiparallel to its magnetization direction in the other remanent state.

10. The disk of claim 9 wherein the lower ferromagnetic layers are formed of substantially the same material, and wherein the second ferromagnetic layer has a thickness less than the thickness of each of the first and third lower ferromagnetic layers.

11. The disk of claim 9 wherein the upper ferromagnetic layer is an alloy comprising Co, Pt, Cr and B, and wherein each of the lower ferromagnetic layers is an alloy comprising Co and Cr.

12. The disk of claim 11 wherein each of the lower ferromagnetic layers is an alloy further comprising Ta.

13. The disk of claim 9 wherein each of the antiferromagnetically coupling layers a material selected from the group consisting of ruthenium (Ru), chromium (Cr), rhodium (Rh), iridium (Ir), copper (Cu), and their alloys.

14. The disk of claim 9 further comprising an underlayer located on the substrate between the substrate and the structure.

15. The disk of claim 9 further comprising a protective overcoat formed over the upper ferromagnetic layer.